



WOODS HOLE OCEANOGRAPHIC INSTITUTION

Applied Ocean Physics and Engineering Department

November 9, 2017

Dr. Robert Headrick
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Dear Dr. Headrick:

Enclosed is the Final Report for ONR Grant No. N00014-14-1-0040/N00014-16-1-2361 entitled "Shallow Water Acoustic Studies," Principal Investigator, Dr. James F. Lynch

Sincerely,

Gretchen McManamin
Administrative Associate I

Enclosure

cc: ✓ Defense Technical Information Center
Naval Research Laboratory
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Shallow Water Acoustics Studies – Final Technical Report

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LONG TERM GOALS

The long term goals of our shallow water acoustics work were to: 1) understand the nature of low frequency (10-1500 Hz) acoustic propagation, scattering and noise in shallow water when strong oceanic variability is present in the form of fronts, eddies, boundary layers, and internal waves (using the SW06 and QPE data, primarily) and 2) initiate planning a 2016 bottom acoustics experiment in the Mid-Atlantic Bight and a 2017 field experiment to look at the complicated boundary between deep and shallow water, i.e. the slope/canyon region.

OBJECTIVES

Our primary objectives in the last year were to: 1) finish manuscripts on the QPE shallow water acoustics/Uncertainty work, and publish them in IEEE JOE, 2) begin 2016 (bottom acoustics) and 2017 (Arctic slope and canyon) experimental planning, both on an individual basis, and in conjunction with the whole ocean acoustics community, 3) continue work on modeling scattering by coastal internal waves and other features and 4) look at climate change effects in shallow water.

APPROACH

We devoted a fair effort this year towards finishing the manuscripts on the fall 2009 QPE Uncertainty experiment northeast of Taiwan. We had two manuscripts published by IEEE JOE (one on canyons and one on the Dyer/Abbot PPD).

The work on internal wave scattering of sound continues, and we have looked at mode coupling, ducting by curved waves, and high frequency energy fluctuations,

among other topics. A *J. Atmos. And Oceanic Tech.* paper was published on this work, and another JASA paper is in advanced preparation.

Planning for the next two shallow water experiments was also part of our effort, though at a more modest level due to the delays in the experiments.

Work on climate change effects upon shallow water acoustics was initiated, and is being pursued in 2017, with Lynch as an Emeritus Scientist.

WORK COMPLETED/ACCOMPLISHMENTS

As seen in the References, we had five peer reviewed papers published due to work in the last two years, with other papers on shallow water acoustics being in preparation by Lynch (working in Emeritus Scientist status) and colleagues.

RESULTS

One of our more interesting results was actually on the fluctuation statistics of coastal nonlinear internal waves, derived using the SW06 data. These statistics, which were previously poorly defined, are direct inputs to acoustic scattering models.

IMPACT/APPLICATIONS

The impact of our experiment should be: 1) an increased understanding of the propagation of sound through complicated coastal oceanography, 2) an eventual capability to model these effects for use in sonar performance prediction applications, and 3) showing that the PPD formalism for detection could be a useful extension of the usual sonar equation ROC curves.

TRANSITIONS

One eventual transition of our analyses will be in “the error bars” one needs to place upon ocean acoustic field and system performance predictions. Another transition is the use of our SW06 internal wave data to verify a large “coastal oceanography plus internal wave” model developed under the IODA (Integrated Ocean Dynamics and Acoustics) MURI, which might eventually be used as a Navy standard model that works at all ocean scales down to the internal waves and finescale

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